

ABSTRACT

Coffman, Bart A. M.S.A.B.E., Purdue University, August, 2009. Evaluation of a Linear Shredder Considering Energy and Material Activity Access. Major Professor: Dennis Buckmaster.

A leachate ion conductivity test was used to evaluate the activity access of mechanically processed whole-plant corn and corn stover. The test procedure was refined with regard to material loading and incubation time to yield a rapid (10 minutes) procedure for detecting differences among mechanical treatments. Conductivity increased with material loading and showed only limited saturation at loadings up to 0.108 g sample/mL water; however, low sample bulk density limited practical material loading to 0.042 g sample/mL water when using unground samples (which had particles larger than 19 mm). Abrasive cyclone milling with a 1 mm screen produced small enough particles to achieve near ultimate conductivity with less than 6 h of incubation. Conductivity of leachate from biomass processed with different mechanical treatments was divided by the conductivity of leachate from cyclone milled biomass to compute an index (0 to 1 scale) which normalizes results for actual chemical composition and indicates access to plant constituents in the processed biomass. Limited data suggests that conductivity index may be related to glucose conversion during enzyme hydrolysis.

A prototype linear shredder was used to shred rehydrated dry corn stover; shredding energy and the activity access of the shredded material were recorded. Shredding process variables were machine compressive pressure (7

to 12 kPa), shredding cycles (resulting in motion of 1.22 to 3.66 m), and stover moisture content (15 and 30%, wet basis). Specific shredding energy ranged from 20 kJ kg⁻¹ DM to 106 kJ kg⁻¹ DM; this is 0.11% to 0.60% of the corn stover's gross heating value. Material conductivity index ranged from 0.36 to 0.81. Regression models for specific shredding energy and material conductivity index were generated and may have value for optimizing mechanical pre-processing treatments of biomass. Generally, high compressive force and wetter material yielded more efficient mechanical processing.